Application No: 17-12-011, et al.

Exhibit No.:

Witnesses: M. Baumhefner

M. Whited

OPENING TESTIMONY OF THE NATURAL RESOURCES DEFENSE COUNCIL

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I. THE PROPOSED DEFAULT RATES COULD UNDERMINE THE STATE'S ABILITY TO MEET ITS CLIMATE AND CLEAN ENERGY GOALS AT THE LOWEST COST – WITNESS MAX BAUMHEFNER

California Senate Bill (SB) 32 (Pavley, 2016) requires that statewide emissions of greenhouse gases (GHGs) be reduced 40 percent below 1990 levels by 2030 in the most cost-effective manner possible. The E3 PATHWAYS model confirms that beneficial electrification of most transportation and building end uses is a key least-cost pathway to complying with SB 32.[1] In other words, the state's ability to meet its climate goals in the most cost-effective manner depends on high customer adoption of electric vehicles (EVs) and building electrification equipment. Likewise, the cost of meeting the requirements established by SB 100 (De León, 2018), that 60 percent of state's electricity be procured from renewable resources by 2030 and 100 percent be carbon-free by 2045, will largely depend on the state's success in using low-cost and no-cost options, such as effective rate design that encourages customers to leverage the same technologies needed to meet California's GHG requirements at the lowest cost, such as EVs and "smart" heat-pumps. This synergy was codified by SB 350 (De León, 2015) in Public Utilities Code §740.12(a)(1)(G):

> *Deploying electric vehicles should assist in grid management, integrating generation from eligible renewable energy resources, and reducing fuel costs for vehicle drivers who charge in a manner consistent with electrical grid conditions.*

The same E3 report underscores why customer-facing policies and price signals will be of such importance as the state seeks to meet increasingly ambitious climate goals, since "a key challenge is convincing millions of households and businesses to adopt these technologies and become the drivers of change to a low-carbon economy."[2] Residential rate design will be a cornerstone policy for driving this transformation.

The Commission has long recognized the potential for TOU rates to provide wide-ranging benefits to customers. As stated in D.17-01-006, "TOU rates better reflect cost causation and motivate customers to shift their usage to periods that promote more efficient use of the

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[1] Energy and Environmental Economics, *Deep Decarbonization in a High Renewables Future: Updated Results from the California PATHWAYS Model*, prepared for the California Energy Commission, June 2018.
[2] *Ibid*, pg. 5.

electrical system. This shift should assist in reaching state energy goals by minimizing costs, encouraging energy conservation at appropriate times, and increasing electric supply at times that best serve the needs of the electric grid."[3] Well-designed TOU rates encourage customers to shift load away from hours with higher costs and emissions to hours with abundant, low-cost renewable energy. Importantly, TOU rates can also help to motivate customers to adopt beneficial electrification technologies such as heat pumps and EVs, and to use these technologies in ways that benefit the grid. In doing so, customers reduce their own energy bills, while helping to reduce system costs and mitigate environmental impacts. <u>Unfortunately, the state is not currently on a path to realize this vision and the proposed default rates will not improve the situation.</u>

A. Smart rate design combined with smart technologies can minimize the cost of meeting the state's climate and clean energy goals

Rates can convey important price signals regarding when to use electricity in ways that can benefit *all* electric customers. The grid is significantly underutilized during the overnight hours when the overwhelming majority of residential customers are asleep; similarly, California's grid is often flooded with inexpensive solar power during sunny days when residential demand also wanes. The GHG profile of California's electricity tends to be lowest at both of these times, when it would be ideal for customers to charge their EVs and electric water heaters and pre-cool or pre-heat their homes. Flexible electricity use can help integrate even more renewable power into the electric grid and can reduce the cost of meeting California's economy-wide GHG goals by tens of billions of dollars per year:

> *… if flexible loads in buildings, flexible electric vehicle charging, and flexible hydrogen electrolysis are also not available and other sectoral strategies are unchanged, the annual cost premium would reach $36 billion per year by 2050.*[4]

But customers will only know to use electricity at the cheapest and cleanest times of day if they are taking service on rates that transmit strong enough price signals that rewards them for their grid-optimal behavior. Well-differentiated rates have shown to drive consumers to use clean, cheap electricity at the right times. Analysis of the IOU's most recent load research reports shows that "EV customers on [opt-in] TOU rates consistently consume a far lower percentage of

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[3] CPUC, D.17-01-006, p.4
[4] Energy and Environmental Economics, pg. 41.

their electricity during on-peak hours compared to standard residential customers," and that, "separately metered EVs consume less than 5 percent of their peak levels during system peaks."[5]

Unfortunately, less than a quarter of the EVs in IOU service territory are taking service on TOU rates, which means that three-of-four EV drivers have no incentive to do anything other than plug-in as soon as they get home, exacerbating evening peak demand.

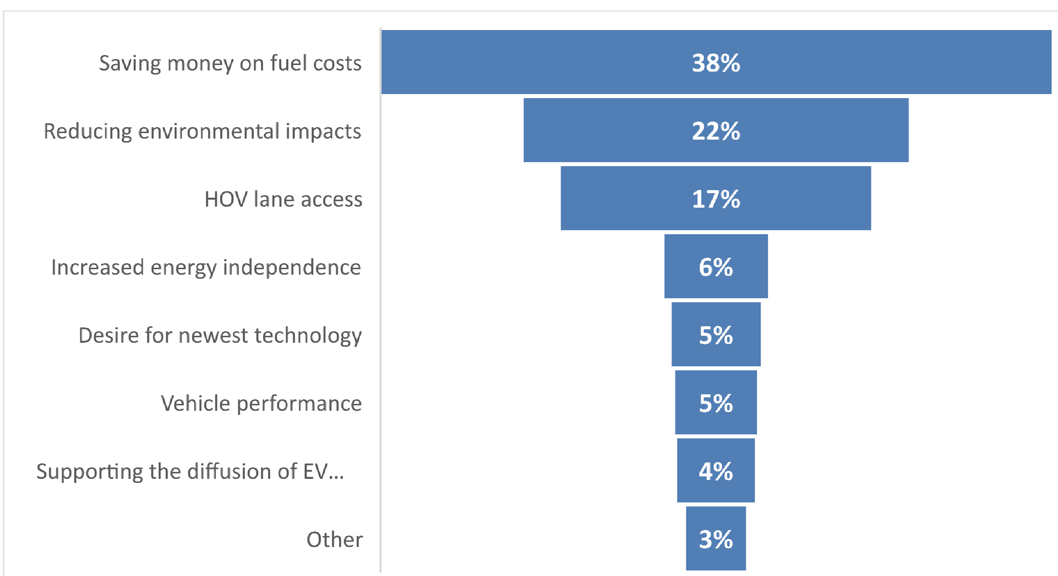
Table 1: Percent of EVs Taking Service on TOU Rates[6]

	PG&E	SCE	SDG&E	Total
% of EVs on TOU rates	26%	15%	38%	23%

B. Rate design will determine the customer economics of beneficial electrification

As has been documented by numerous surveys, saving money relative to gasoline is the single biggest motivator of EV purchase decisions.

Figure 1: Most Important Reason to Acquire and EV[7]



[5] Synapse Energy Economics, *Electric Vehicles Still Not Crashing the Grid: Updates from California*, prepared for the Natural Resources Defense Council, March 2018, pg. 2-3.
[6] Data source: *Joint IOU Load Research Report*, 2017.
[7] Center for Sustainable Energy, *California Plug-in Electric Vehicle Owner Survey Dashboard*.

Unfortunately, because three-out-of-four EVs in IOU service territory are taking service on default rates, that incremental EV load is generally occurring on upper tier prices that can equal or exceed the equivalent of driving on gasoline. In sum, most early EV adopters are being sold a bill-of-goods, which is no way to build the mass-market necessary to meet California's climate and clean energy goals in the most cost-effective manner.

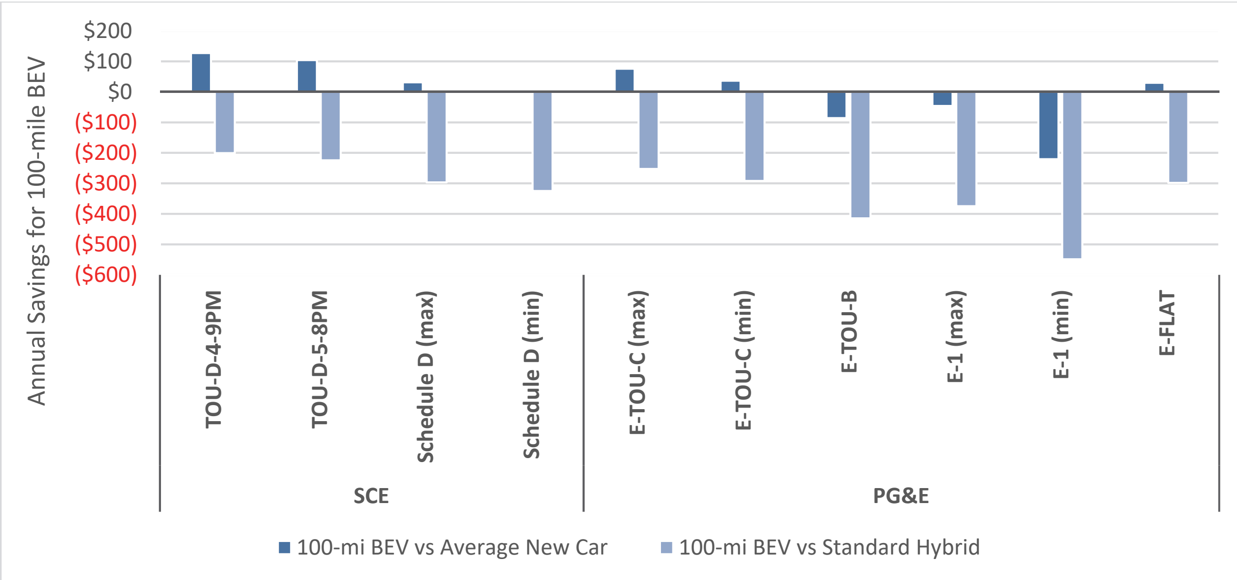
For many years, NRDC and other stakeholders have been calling attention to this issue, and we have generally been told that the transition to default TOU rates would solve the problem by overcoming the challenges associated with enrolling customers onto voluntary rates designed for EVs. The promised solution is soon to be upon us, but it falls short.

C. The proposed default TOU rates will not deliver the fuel cost savings that motivate EV and heat pump adoption, are not well designed to encourage behavior that supports the grid, and run afoul of Public Utilities Code § 740.12

Now that the IOUs have proposed the highly anticipated default TOU rates, our analysis reveals that EV drivers and customers who invest in beneficial electrification and operate their equipment to reduce costs for *all* Californians—charging almost exclusively during periods of low grid utilization and GHG emissions—would not realize significant savings, and could actually be harmed under under the new default rates.

As the analysis included in the testimony of Melissa Whited reveals, EV customers would only realize *de minimis* savings relative to driving an average gasoline vehicle, and would pay substantially more than they would have if they were driving a gasoline hybrid vehicle (which is an apt comparison because EV drivers are often former hybrid drivers), as depicted in the negative light blue bars in Figure 2.

Figure 2: Annual Savings for 100 Mile Battery Electric Vehicle (BEV)



Recall that these results are for EV drivers who are charging almost exclusively during off-peak hours. Accordingly, the proposed default rates violate P.U. Code § 740.12's directive that EV adoption should reduce "fuel costs for vehicle drivers who charge in a manner consistent with electrical grid conditions."

Rate design will possibly be even more influential for the beneficial building electrification market, since the fuel comparison in those use cases offers a smaller margin from which fuel savings can be attained. Furthermore, beneficial electrification purchases do not carry the kind of *cache* that a new EV might and they are usually hidden inside the walls of a home (e.g. water heaters and space heaters). For these reasons, the success of beneficial electrification in California will likely depend on delivering significant bill savings to customers through rate design. Unfortunately, the analysis of Ms. Whited reveals the utilities' proposed TOU rates would provide bill savings of only about $5 per month for customers with space or hot water heat pumps who shift their entire space or hot water heat pump load to off- peak hours. Customers who invest in the cleanest technologies and who use them to support the electric grid should realize much more significant benefits.

D. We may not be able to optimize the default TOU rates for beneficial electrification, but we should improve them to benefit all customers

Defaults matter: most customers will stay on the rate they are defaulted to. In light of this demonstrated customer inertia, the Commission wisely decided that the initial default TOU rates should feature relatively mild differentials during the transition period to allow customers to learn and understand the new rate structure before being subject to differentials that could produce significant rate shock. But many of the proposed defaults differentials are beyond mild. In fact, PG&E's proposed default rates are TOU rates in name only. A differential of 1.06 will not provide customers an opportunity to understand a time-differentiated rate and learn about optimizing their electricity use patterns. This new rate will be ignored, and California will have wasted the "first step" in a transition to residential TOU rates. Likewise, SCE's proposed rates are too complex in their structure, with TOU periods that exist in one season and not in another, and differences between weekdays and weekends that will confound consumer understanding. The default rates should offer simple, understandable structures with mild yet meaningful price differentials that give their customers a real opportunity to learn about the new time-differentiated rate structure. As Ms. Whited details, SCE's rates should generally be simplified so that people can understand them and respond to them, and PG&E's rates should incorporate on-peak to off-peak price ratios that go beyond a rounding error so that customers actually have a reason to respond and shift load to hours that support and not strain the grid.

E. The IOUs should use this unique opportunity to default EV, beneficial electrification, and other motivated customers onto rates that are more cost reflective and that will encourage those customers to respond in a manner that benefits all utility customers

The transition to default TOU rates provides a singular opportunity to overcome the lack of enrollment on voluntary TOU rates that are optimized for EVs and other smart beneficial electrification loads. Given the new default rates fail to provide the fuel cost savings needed to accelerate the transportation and building electrification required to meet the state's climate and clean energy goals cost-effectively, it is critical that we do not squander this singular opportunity to enroll customers with EVs, heat-pumps, or other motivated customers onto rates that are more cost-reflective and that encourage behavior that supports the grid.

Unfortunately, the set of rates proposed in PG&E's and SCE's applications run afoul of D.15-07-001's directive to "offer a menu of different residential rates designed to appeal to a variety of residential customers."[8] By limiting the menu of TOU rates they will offer to customers at this transition point, the utilities will miss a unique opportunity to fix the problem we are stuck with today. Instead, the utilities should default EV, heat-pump, and other motivated customers onto tariffs such as SCE's pending TOU-PRIME and PG&E's EV rates, which will both deliver the fuel cost savings necessary to meet California's climate goals and which will also reward behavior that improves the utilization of the grid to the benefit of all utility customers, avoiding unnecessary costs associated with integrating those loads and lowering the costs of integrating variable renewable resources as well.

II. THE PROPOSED DEFAULT TOU RATES AND THE TRANSITION TO THOSE RATES SHOULD BE MODIFIED TO PROVIDE WIDESPREAD ECONOMIC BENEIFTS -- WITNESS MELISSA WHITED

A. Summary of Findings and Recommendations

At the point of transition, it is appropriate for default TOU rates to have relatively modest rate differentials to enable customers to learn how to respond to the new rates. However, the default rates will also become the new standard rate for most residential customers, as experience has shown that most customers remain do not opt to switch to new rates from the default. Thus residential customers' decisions whether to shift load or adopt new technologies will disproportionately depend on the price signals provided by the TOU rates that these customers are defaulted onto.

Therefore, it is critical that the default rates provide customers with simple, meaningful price signals, rather than providing complex TOU periods or trivial rate differentials. Based on our analysis described in the following sections, we find that SCE and PG&E's proposed default TOU rates and the transition to those rates should be improved to better accomplish the objectives of California's residential rate reform. Our recommendations are as follows:

1) The default TOU rates should have peak to off-peak price ratios that provide a meaningful price signal for customers. Our analysis indicates that the utilities' proposed TOU rates would provide bill savings of only about $5 per month for customers with space or hot water heat pumps who shift their entire space or hot

[8] D.15-07-001, pg. 176.

water heat pump load to off-peak hours. Such savings are unlikely to motivate behavioral change or drive customer adoption of smart appliances, despite their potential to serve as a valuable grid resource for load shifting and flexibility.[9] Further, the vast majority of EV owners currently take service on standard residential rates.[10] Under the utilities' proposals, these customers would be moved to one of the utilities' default TOU rates, which will provide minimal or even negative cost savings relative to comparable gasoline vehicles. And because the default TOU rates often fail to provide meaningful on-peak to off-peak price differentiation, these EV customers are much more likely to simply plug in when they get home from work, exacerbating evening peaks and driving up costs for all customers.[11]

2) The utilities should propose a menu of rate options that include proposals that would provide substantially stronger price signals than the default TOU rates.

3) The utilities should take advantage of this opportunity to default customers with beneficial electrification technologies, particularly EVs and heat-pumps, onto rates that would provide appropriate fuel cost savings and strong incentives for shifting load off-peak. Examples of such rates include SCE's PRIME rate schedule and PG&E's EV rate schedules. This recommendation does not apply to PG&E's E-DER-A rate, this rate does not provide useful price signals.

4) The Commission should not approve PG&E's E-DER-A pilot, as the inclusion of a large non-coincident demand charge of $11.63/kW is inconsistent with the principles of cost causation and encouraging beneficial energy usage, as recently reiterated by the Commission in D. 18-08-013 PG&E's GRC Phase II proceeding.

5) SCE's rates should be simplified to no more than three TOU periods that are constant throughout the year, even if the prices during those periods change. Doing so will

[9] Ryan Hledik, Judy Chang, and Roger Lueken, "The Hidden Battery: Opportunities in Electric Water Heating," n.d.
[10] Synapse Energy Economics analysis of data provided in the 6th Joint IOU Electric Vehicle Load Research Report: December 2017
[11] As noted in the 6th Joint IOU Electric Vehicle Load Research Report: December 2017, p. 93: EV customers that remain on typical residential rates tend to show less usage during the off-peak hours and "increased usage during the afternoon-evening hours relative to those on PEV rates."

make it easier for customers to understand the rates and to remember when peak and off-peak periods occur.

In sum, improving the utilities' default TOU rate proposals and seizing the singular opportunity that will exist during the transition is important for avoiding unnecessary upgrades to the distribution system, while improving overall system utilization. If designed well, default TOU rates will drive down costs for all customers by supporting beneficial electrification and efficient use of the system. But if instead customers are defaulted onto rates that are confusing or provide inadequate incentive to motivate customer action, this opportunity will be squandered.

B. SCE and PG&E's Proposed Default TOU Rates

1. SCE's Proposed Default TOU Rates

SCE's two proposed default TOU rates, TOU-D-4-9PM and TOU-D-5-8PM, are structured in a very similar manner, other than the duration of the on-peak period. Both have four periods: super off-peak, off-peak, mid-peak, and on-peak, although only three periods are applicable in any one season. The tables below summarize the proposed rates.

Table 2. SCE's Proposed Default TOU-D-4-9PM Rate

TOU-D-4-9PM	Period	Weekday Hours	Weekend Hours	$/kWh	Ratio
Summer	Super-Off-Peak	N/A	N/A	N/A	1.85
	Off-Peak	9 pm - 4 pm	9 pm - 4 pm	0.22	
	Mid-Peak	N/A	4 pm - 9 pm	0.27	
	On-Peak	4 pm - 9 pm	N/A	0.41	
Winter	Super-Off-Peak	8 am - 4 pm	8 am - 4 pm	0.17	1.72
	Off-Peak	9 pm - 8 am	9 pm - 8 am	0.28	
	Mid-Peak	4 pm - 9 pm	4 pm - 9 pm	0.29	
	On-Peak	N/A	N/A	N/A	

Table 3. SCE's Proposed Default TOU-D-5-8PM Rate

TOU-D-5-8PM					
	Period	Weekday Hours	Weekend Hours	$/kWh	Ratio
Summer	Super-Off-Peak	N/A	N/A	N/A	2.12
	Off-Peak	8 pm - 5 pm	8 pm - 5 pm	0.23	
	Mid-Peak	N/A	5 pm - 8 pm	0.29	
	On-Peak	5 pm - 8 pm	N/A	0.49	
Winter	Super-Off-Peak	8 am - 5 pm	8 am - 5 pm	0.17	1.77
	Off-Peak	8 pm - 8 am	8 pm - 8 am	0.29	
	Mid-Peak	5 pm - 8 pm	5 pm -89 pm	0.30	
	On-Peak	N/A	N/A	N/A	

As discussed in the following sections, these rates reflect relatively modest peak to off-peak price ratios while also being unnecessarily complex.

2. PG&E's Proposed Default TOU Rates

PG&E has proposed four "core" rate options, consisting of two TOU rates and two non-TOU rates. E-TOU-C would be the default TOU rate and features a tiered pricing structure, while the optional TOU rate (E-TOU-B) is not tiered. The on-peak period for the default E-TOU-C rate is 4:00 pm – 9:00 pm on all days, while the on-peak period for the optional E-TOU-B is constrained to weekdays between 5:00 pm – 8:00 pm. The TOU rates are shown in Table X below.

Table 4. PG&E's Proposed Default E-TOU-C Rate

E-TOU-C					
	Period	Hours (All Days)	Tier 1 $/kWh	Tier 2 $/kWh	Ratio
Summer	Off-Peak	9 pm - 4 pm	0.18	0.26	1.24
	On-Peak	4 pm - 9 pm	0.25	0.33	
Winter	Off-Peak	9 pm - 4 pm	0.19	0.28	1.06
	On-Peak	4 pm - 9 pm	0.21	0.29	
Minimum Bill				$15.00	

Table 5. PG&E's Proposed Optional E-TOU-B Rate

E-TOU-B	Period	Weekday Hours	$/kWh	Ratio
Summer	Off-Peak	8 pm - 5 pm	0.23	1.41
	On-Peak	5 pm - 8 pm	0.33	
Winter	Off-Peak	8 pm - 5 pm	0.23	1.07
	On-Peak	5 pm - 8 pm	0.25	
Minimum Bill			$15.00	

Both E-TOU-C and E-TOU-B exhibit only very modest on-peak to off-peak price ratios:

- E-TOU-C has a summer peak to off-peak price ratio of 1.24 and a winter price ratio of 1.06. The differential between summer peak and off-peak rates is only $0.06/kWh, while the difference between winter peak and off-peak rates is only $0.02/kWh.
- E-TOU-B has a summer peak to off-peak price ratio of 1.41 and a winter price ratio of 1.07. The differential between summer peak and off-peak rates is only $0.09/kWh, while the difference between winter peak and off-peak rates is only $0.02/kWh.

Although PG&E's rates are simple and likely to be easily understood by customers, their peak to off-peak price ratios are so low as to be nearly meaningless.

C. Analysis of Rate Design Impacts on Beneficial Electrification

TOU rates with low peak to off-peak price ratios provide little incentive for customers to adopt smart technologies such as heat pump water heaters and EVs that can be programmed to shift load off-peak, thereby hindering the market development of such technologies. Further, flattened rates penalize customers who have invested in these technologies with the expectation that they could reduce their operational costs by shifting their usage to off-peak hours. Below we describe the quantitative analysis that we conducted of PG&E and SCE's rate options, and the results of our analysis.

1. <u>Methodology</u>

To determine the financial impact that the Companies' proposed rate designs would have on customers with beneficial electrification technologies, we conducted two analyses. First, we analyzed the cost savings potential for customers who shift the majority of their heat pump or EV load from on-peak to off-peak hours under the Companies' TOU rates. We expect these results to be most relevant for heat pump water heaters and EVs, both of which have storage properties and can typically be easily "charged" during off-peak hours while still providing the same service to customers.

Second, we analyzed whether the Companies' proposed rates would support customer adoption of heat pump and EV technologies for customers on the rate by providing operational cost savings relative to the conventional technology. To perform this analysis, we developed a detailed spreadsheet model. The model calculates space heating and cooling cost savings (comparing natural gas and electricity), water heating cost savings (comparing natural gas and electricity), and annual vehicle fuel cost savings (comparing gasoline and electricity costs). The model produces results for multiple scenarios based on the utility, climate zone, rate, and vehicle type.[12]

For our analysis of space heating and cooling costs, we assumed that a natural gas furnace combined with a central air conditioning unit would be replaced by a central (ducted) air source heat pump. For our water heating analysis, we assumed a tank-based natural gas boiler would be replaced by a tank-based heat pump water heater.[13] For vehicle fuel cost savings, we compared three representative EVs to an average new ICE vehicle and to a standard ICE hybrid.

For each technology, we used typical load profiles based on California data where possible. Representative space cooling and water heating load profiles were taken from the National Renewable Energy Laboratory's OpenEI database for San Francisco, Los Angeles, and

[12] The vehicle parameters were only incorporated in the analysis of vehicle cost savings; they were not included in the analysis for space and water heat savings

[13] Gas tariff information was taken from the PG&E and Southern California Gas tariff websites. Typical residential load profiles were taken from the most recent year with available data from SCE and PG&E's responses to discovery data requests ("RateDesignWindow2018_DR_NRDC_001-Q3.xlsx" and "NRDC Q.3-Copy of 2015-2016_dom_cz_hourly.xlsx"). Electric vehicle charging profiles were taken from the San Diego Gas & Electric California Docket A.17-01-020, (SDG&E Response to NRDC Data Request No. NRDC-SDG&E-DR-03). Space heating, space cooling, and water heating load shapes and annual energy usage data were taken from OpenEI and RASS 2009.

Sacramento, and then scaled based on the 2009 California Residential Appliance Saturation Study for each region.[14]

Our model assumes that a customer with an EV on a TOU rate charges primarily off-peak, but with occasional on-peak charging, rather than assuming 100 percent off-peak charging.[15] This more realistic charging profile assumption is important for ensuring that customers will have a reasonable opportunity to achieve fuel savings, even when they must occasionally charge during on-peak hours.[16]

2. Results – PG&E

a. *PG&E – Water Heating Cost Savings*

Heat pump water heaters are energy efficient replacements for natural gas water heaters. Further, because of their thermal storage capacity, water heaters have the ability to store energy for later use, essentially operating as a thermal battery. By pre-heating water during hours when demand on the grid is low, electric load can be shifted from peak hours to off-peak hours. On an individual level, each heat pump water heater shifts relatively small amounts of load away from the evening peak, but in aggregate the impacts can be quite large since water heating occurs in virtually every house.[17] However, such load shifting requires sufficient price signals to encourage customers to invest in smart heat pump water heaters and program the heaters to shift load.

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[14] These load profiles were used to derive the counterfactual gas boiler and air conditioning load profiles. Because data was unavailable for Sacramento, its annual space cooling profile was scaled from the other regions by its relative Cooling Degree Days, and its water heating load was assumed to be equivalent to that of San Francisco. The gas boiler load profile was converted to kWh for heat pump water heaters, scaled by a relative efficiency factor calculated at 21% (i.e., HPWHs use 79% less energy than gas boilers). ASHP cooling loads are assumed to be equivalent to that of a traditional new central air conditioning system, due to an equivalent SEER rating.

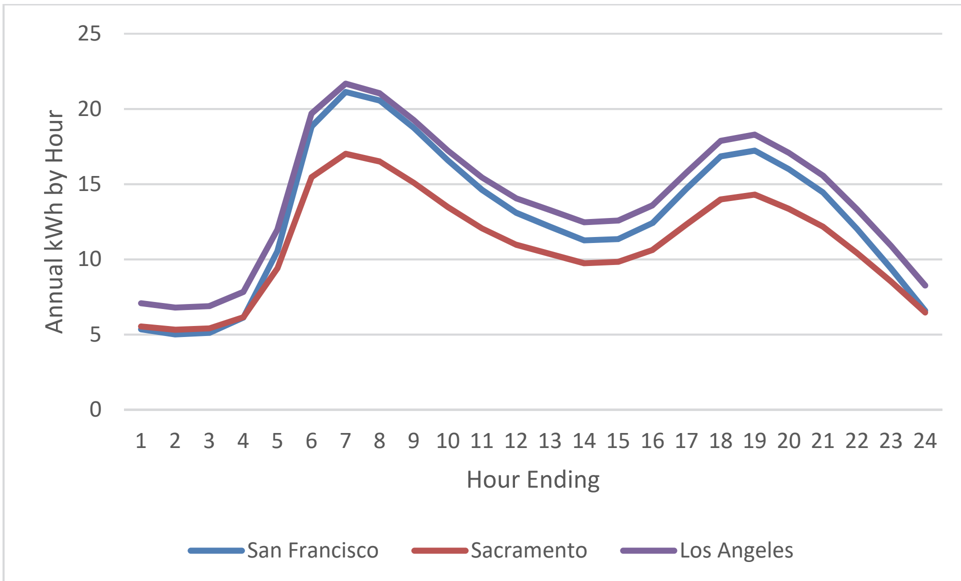
[15] This charging behavior is based on that previously observed for SDG&E customers facing TOU rates. For the 4-9 pm rates, we assumed 76% of charging occurred off-peak. For the 5-8 pm rates, we assumed 85% of charging occurred off peak.

[16] This has been previously recognized by the Commission in D.11-07-029 Establishing Policies to Overcome Barriers to Electric Vehicle Deployment and Complying with Public Utilities Code Section 740.2, July 14, 2011, 15.

[17] Pierre Delforge and Ben Larson, "HPWH Demand Flexibility Study," (March 20, 2018), https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20and%20Connected%20Water%20Heaters%20Stakeholder%20Meeting_%203%2020%202018_final.pdf.

Water heater load profiles for California indicate that the majority of heat pump water heater load occurs during off-peak hours. However, there is a sizeable quantity of load in the evening hours that could potentially be shifted earlier in the day by pre-heating. Figure 3 shows the heat pump water heating load profiles used in our analysis.

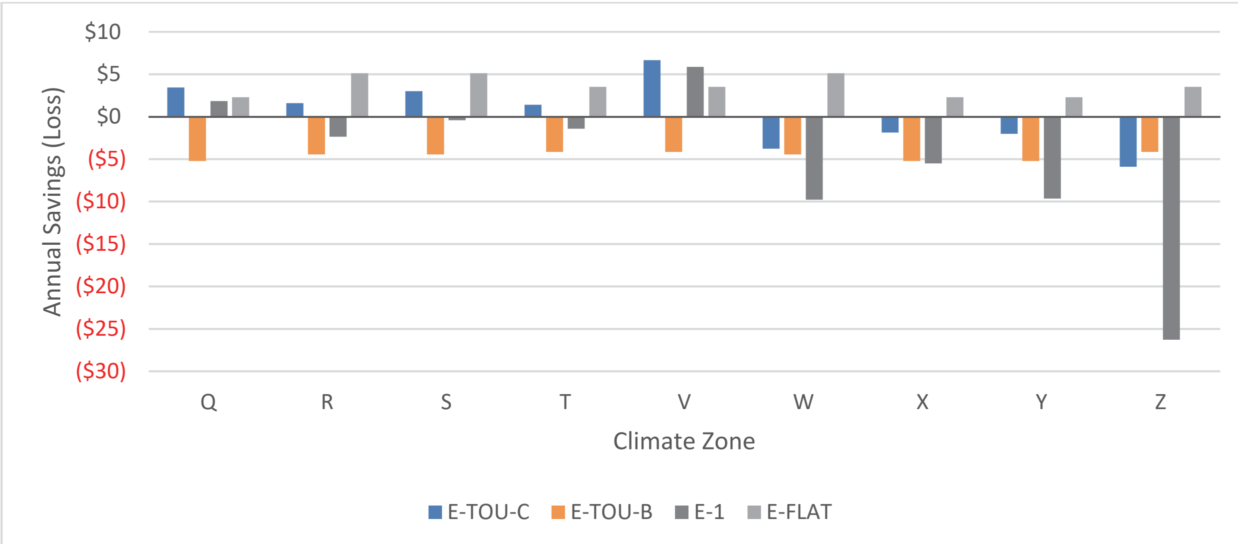
Figure 3. Estimated Heat Pump Water Heater Load



Our analysis indicates that a customer who shifts 100% of his or her heat pump water heater load from peak to off-peak hours would experience minimal savings on the PG&E's TOU rates. We estimate these savings would average between $3 and $5 per month, depending on the climate zone. These low savings are unlikely to motivate customers to invest in smart technologies to shift this load.

Further, PG&E's rates do little to improve the economics of converting to heat pump water heaters from natural gas. Customers who are considering adopting (or who have adopted) heat pump water heaters would experience only slight savings on PG&E's E-TOU-C rate, with slight *negative* savings on the E-TOU-B rate relative to a natural gas heater. This is shown in Figure 4 below.

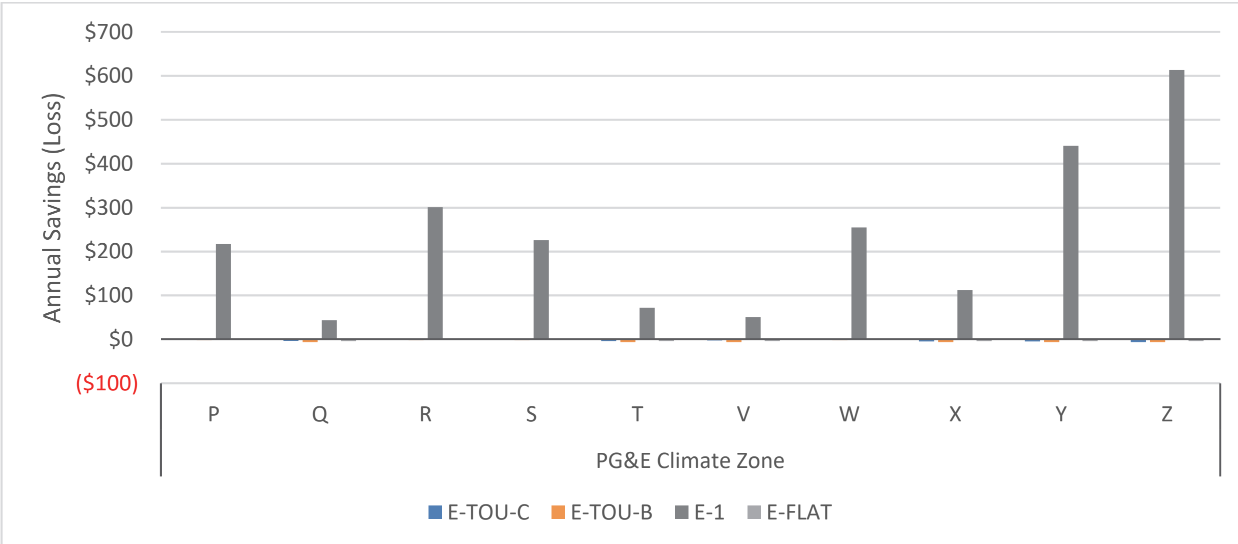
Figure 4. Annual savings on water heating costs from switching to a heat pump water heater in PG&E territory by rate schedule.



b. *PG&E - Efficient Space Heating and Cooling Cost Savings*

As shown in Figure 5, customers who are on PG&E's TOU rates would experience negligible savings from trading their conventional air conditioner and natural gas heater for an air source heat pump. Depending on the climate zone, the tiered rate generally provides customers with the strongest incentive to switch to an air source heat pump, as the tiered rate provides substantial cost savings (exceeding $600 annually in climate zone Z). This effect is due to the energy efficiency (and reduced electricity consumption) provided by the air source heat pump.

Figure 5. Annual savings from space heating and cooling costs due to switching to an air source heat pump (ASHP) in PG&E territory by rate schedule.



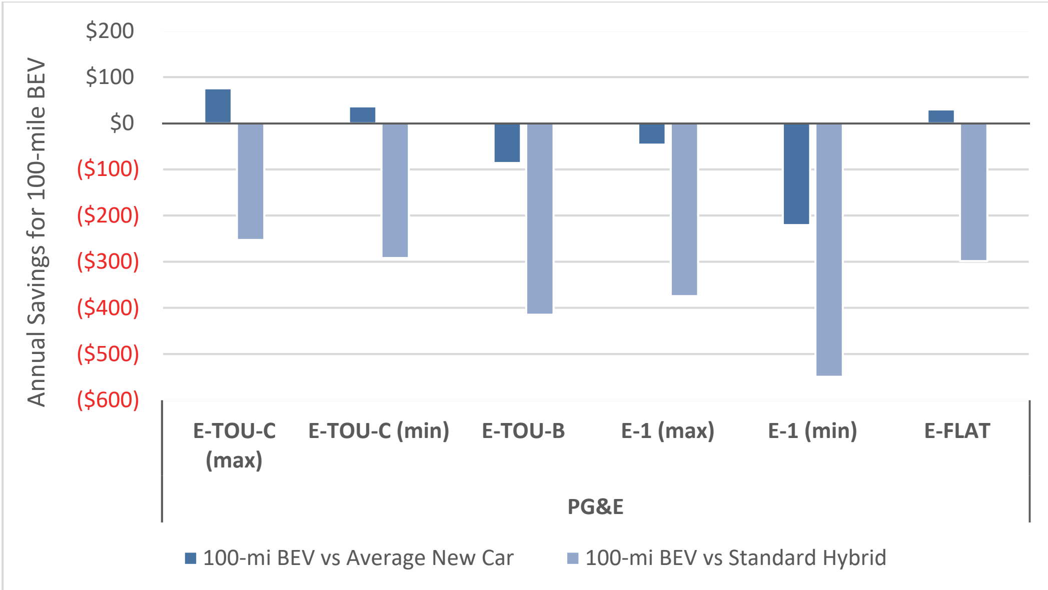
c. *PG&E Vehicle Fuel Cost Savings*

As described above, our model assumes that a customer with an EV on a TOU rate charges primarily off-peak, but with occasional on-peak charging.[18] The fuel cost savings relative to an ICE for each of PG&E's proposed rates are shown in Figure 6 below. The figure provides the minimum and maximum fuel cost savings for the tiered rates due to the variation across climate zones.

None of PG&E's rates provide more than $10 per month in fuel cost savings for a 100-mile BEV when compared to an average new ICE vehicle, and all of the rate designs result in losses (i.e., higher fuel costs) when compared to a standard ICE hybrid (such as a Toyota Prius), a 100-mile BEV would result in higher fuel costs ranging from approximately $300 to $550 on PG&E's TOU rates.

[18] Specifically, we assumed that on the rates with peak periods from 4 to 9 pm, 76% of charging would occur off-peak, while for the peak periods from 5 to 8 pm, 85% of charging would occur off-peak.

Figure 6. Fuel cost savings (losses) for a 100-mile BEV relative to an average new car or a hybrid.



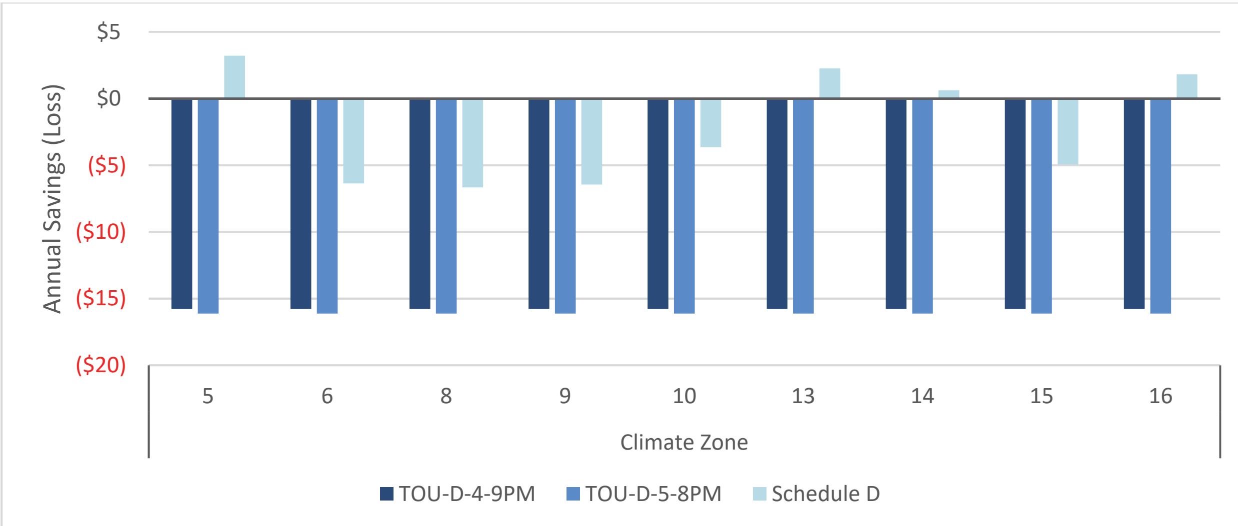
3. Results - SCE

a. *SCE - Water Heating Cost Savings*

Similar to the results of PG&E's rates, SCE's TOU rates provide minimal savings for customers who adopt efficient heat pump water heaters and who shift 100% of their heat pump load to off-peak hours. We estimate such savings would be in the range of $4 to $7 per month on average.

For customers who do not shift their water heating load to off-peak hours, Figure 7 illustrates that neither of SCE's proposed TOU rates would improve the economics for customers to convert their natural gas water heaters to heat pumps. Doing so would result in a slight annual loss of approximately $15 on SCE's TOU rates.

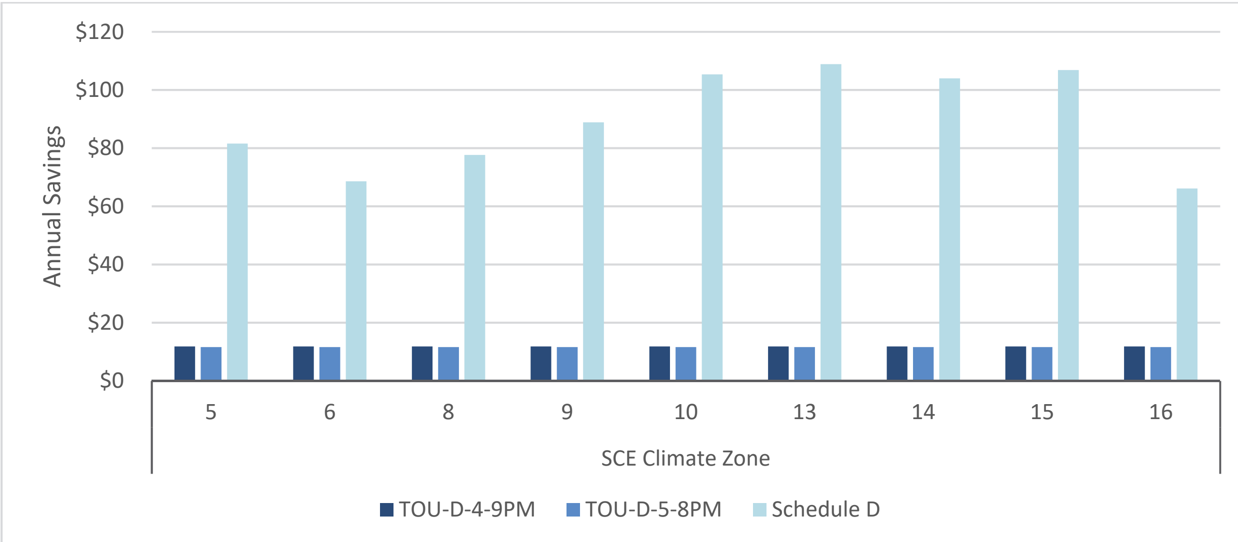
Figure 7. Annual savings on water heating costs from switching to a heat pump water heater in SCE territory.



b. *SCE - Efficient Space Heating and Cooling Cost Savings*

As shown in Figure 8 below, customers on SCE's TOU rates will experience very small annual space heating and cooling savings of approximately $10 annually, regardless of the climate zone. However, customers with an ASHP would most benefit from the tiered rate (Schedule D), as we assume that customers would be replacing a less efficient air conditioner and thus reducing their highest tier costs. In sum, the transition from the current default rates to the new default rates would diminish the incentive for customers to adopt this efficient technology.

Figure 8. Annual savings from space heating and cooling costs due to switching to an air source heat pump (ASHP) in SCE territory.



c. *SCE Vehicle Fuel Cost Savings*

The financial implications for each of SCE's TOU rates (TOU-D-4-9PM and TOU-D-5-8PM) are similar and are shown in Table 6. Under both SCE TOU rates, a customer purchasing a BEV and charging primarily off-peak would experience modest fuel cost savings of between $100 to $200 per year relative to a typical new gasoline-powered vehicle. However, a customer purchasing a 40-mile PHEV (with slightly lower fuel economy) would experience *negative* fuel savings, resulting in higher fueling costs of more than $250 per year.

When compared to a standard hybrid vehicle, such as a Toyota Prius, all EV fuel savings disappear. Relative to a standard ICE hybrid, a 40-mile PHEV (similar to a Chevy Volt) would see losses of more than $500 per year, while a BEV would generate losses in the range of $100 to $200 per year. This comparison is important, because customers considering purchasing an EV are likely to compare these vehicles to high-efficiency ICE options, such as standard hybrids.

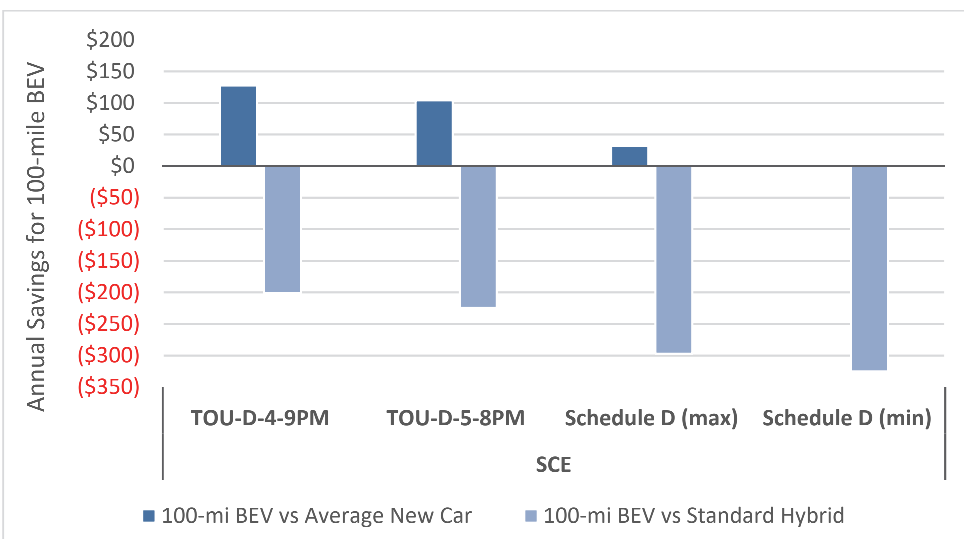
Table 6. Annual Vehicle Cost Savings for SCE TOU-D-4-9PM and TOU-D-5-8PM by counterfactual and replacement BEV vehicle type.

		EV Type		
		40-mile PHEV	*100-mile BEV*	*200-mile BEV*
4-9PM	Average New Car	($265)	$128	$199
	Standard Hybrid	($593)	($201)	($129)
5-8PM	Average New Car	($298)	$104	$178
	Standard Hybrid	($627)	($224)	($151)

The fuel cost savings for EVs on SCE's proposed TOU rates are similar to those on SCE's alternative tiered rate, Schedule D.[19] Fuel cost savings for a 100-mile BEV on Schedule D would likely range from approximately $50 to $150 relative to an average new ICE vehicle, but would result in losses of between $200 and $300 relative to a standard ICE hybrid.

Figure 9 below compares the fuel savings for a 100-mile BEV relative to either an average new ICE vehicle or a standard ICE hybrid for each of SCE's proposed rate schedules. As indicated, fuel cost savings are very modest relative to an average new ICE vehicle, and are negative relative to a standard ICE hybrid.

Figure 9. Fuel cost savings for a 100-mile BEV relative to an ICE on SCE's proposed rates.



[19] The fuel cost savings on Schedule D will vary depending on zone due to different baseline quantities.

D. PG&E's Default TOU Rates Should Provide Meaningful Price Signals

The low peak to off-peak price ratios in PG&E's proposed TOU rates are so flat as to offer little incentive for customers to adjust their behavior or invest in new technologies. While gradual implementation of default TOU rates is appropriate, the peak to off-peak ratios should not be so small that they will be ignored. With no usage shifted, the potential economic efficiency gains from TOU rates are erased, undermining the purpose of implementing them.

PG&E's proposed peak to off-peak price ratios should balance the goals of gradualism, economic efficiency, and support for California's energy policy goals. Specifically, PG&E's peak to off-peak price ratios should be softened relative to the full marginal costs, but should still send price signals that customers notice and respond to, and should help improve the economics of building and transportation electrification. At a minimum, we recommend that PG&E's summer peak to off-peak price ratios be brought to the level of those proposed by SCE in order to send meaningful price signals. Ideally, these price signals would be strengthened further to better reflect marginal costs, as discussed in the following section.

E. PG&E's Rates Should Better Reflect Marginal Costs

PG&E's proposed TOU rates also poorly capture the temporal aspect of its total system marginal costs. PG&E states that its TOU rate differentials are based on marginal costs proposed in its 2017 GRC Phase II proceeding.[20] However, E-TOU-B and E-TOU-C are only based on temporally differentiated marginal *generation* costs, while ignoring the time-differentiated components of marginal distribution costs. As a result, PG&E's proposed rates bear little resemblance to the total marginal cost differentials shown in its 2017 GRC Phase II workpapers.

As shown in PG&E's filing in A.16-06-013, the total marginal costs per kWh in the summer range from $0.18 during the peak period to $0.04 during the summer off-peak period, a differential of $0.14 per kWh.[21] The resulting peak to off-peak price ratio in the summer is 4.6:1. In contrast, PG&E's proposed E-TOU-C rate has a summer differential of only $0.06 per kWh, while the E-TOU-B rate has a differential of only $0.09 per kWh.

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[20] PG&E notes that it made some modifications to the rates, such as making the E-TOU-C rate revenue neutral by season with the flat rate, thereby shifting recovery of some costs from the summer to the winter.

[21] PG&E Workpapers, Phase II GRC A.16-06-013, "Res MCs and Hourly Loads.xlsx" filed December 2, 2016. Total marginal costs use a four month summer period.

Table 7. PG&E's Total Marginal Costs for Residential Customers

Total Marginal Costs per kWh

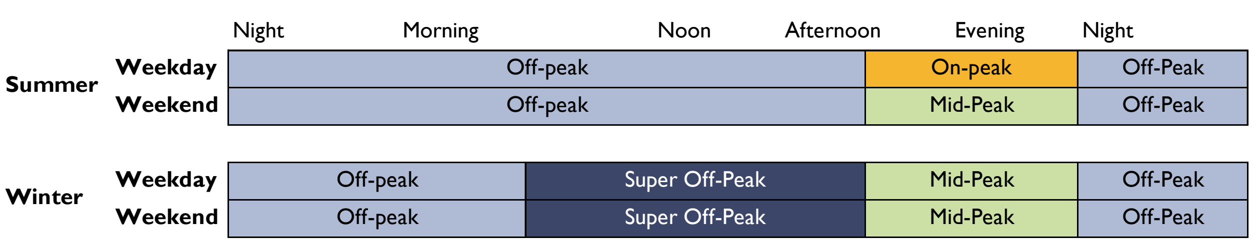
Summer Peak	Summer Part Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak
$0.1758	$0.0799	$0.0381	$0.0473	$0.0269
Summer Differential		$0.14	Winter Differential	$0.02
Peak to Off-Peak Ratio		4.62	Peak to Off-Peak Ratio	1.76

If the Summer Off-Peak and Part-Peak rates are combined, the differential declines to $0.12/kWh during the summer with a peak to off-peak price ratio of 3.3:1. However, this differential is still much greater than the $0.06 per kWh differential embedded in the E-TOU-C rate or the $0.09 differential in the E-TOU-B rate. While it is not necessary for the initial default TOU rates to fully reflect marginal costs, completely ignoring the temporal nature of distribution costs is clearly incorrect.

F. SCE's TOU Rate Proposals Should be Simplified

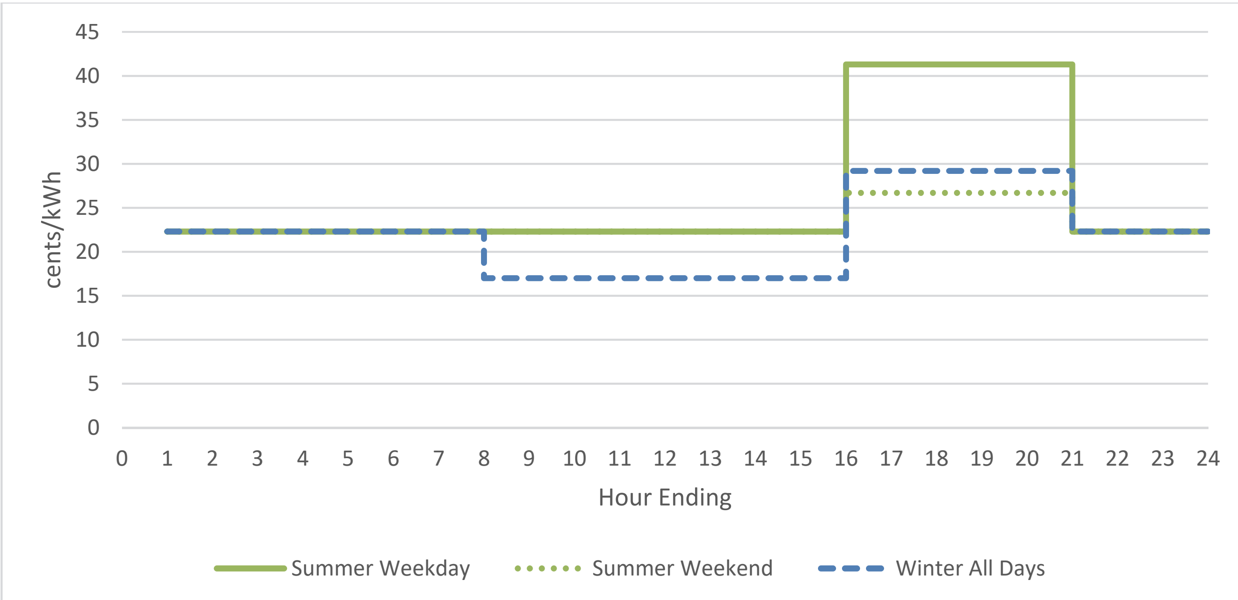
Figure 10 shows a simplified representation of the TOU rates proposed by SCE:

Figure 10. Representation of SCE's Proposed TOU Rate Schedules



Shown together with their representative prices in the graph below (Figure 11) the rates appear complex, varying by season not only in terms of the prices, but also in the number of the number of periods per day (two per day in summer, three in winter) and whether it is the weekend (with weekend prices only applicable in summer).

Figure 11. SCE's proposed TOU periods



California's entry into wide-spread TOU should emphasize simplicity, especially in the context of a residential default rate. Residential customers are generally unaccustomed to time-varying rates, and shifting load typically requires manual adjustments or programming of devices to pre-set periods. To encourage customers to adjust their usage, the default rate should be simple enough for customers to easily remember and to easily program. A small tweak to SCE's proposed default TOU rates would help accomplish this: simply removing the weekend designation would eliminate the need for a fourth period, since each period could now be classified as either off-peak, super off-peak, or on-peak. The prices for each of these periods would vary across seasons, but the rate would no longer vary by day of the week, improving the simplicity and understandability of the rate.

G. A Menu of Rate Designs is Appropriate

Customer preferences within each utility's territory are diverse. While some customers are highly engaged, others have little understanding of their electricity rates. The Commission therefore recognized that a rate with a mild differential would be appropriate as the default rate during the transition period to allow customers to learn and understand the new rate structure before being subject to differentials that could produce significant rate shock.[22]

[22] D.15-07-001, p. 135

At the same time, the Commission recognized that customers who are the most educated about rates should have the opportunity to "take advantage of new and innovative rates and technologies to reduce use during periods with high prices (including real time pricing or matinee rates for customers who have the enthusiasm and interest)."[23] Thus the Commission clearly directed the utilities to "offer a menu of different residential rates designed to appeal to a variety of residential customers, with different time periods and rate differentials."[24]

The range of rates offered by PG&E and SCE fail to comport with the Commission's recommendation in D.17-01-006 that the utilities provide a menu of price options for a variety of customers within a class with enhanced marginal cost signals. As the Commission recently stated in D.18-08-013, "The objective of this menu approach was to give those customers that can adopt load-shifting behavioral changes or technologies firmer price signals with which to assist PG&E in avoiding marginal costs."[25]

Given this guidance from the Commission and the need to support wider adoption of beneficial electrification technologies, the Companies should introduce optional rate options that better accomplish these goals. SCE's TOU-D-PRIME rate as contained in the settlement in A.17-06-030 serves as a good example of such a rate. However, the manner in which such options are introduced to customers is key. Due to the limited engagement that most customers have with their rates, it is important that such a rate be introduced as part of the menu of rate options rolled out at the same time as the default TOU rates. Requiring customers to seek out and educate themselves about rates outside of the default menu would result in very low enrollment rates.

In addition, to combat customer inertia, we recommend that the utilities take a proactive role in enrolling customers with advanced technologies in such a rate. For example, SCE and PG&E should identify EV customers and actively alert these customers during the default TOU roll-out process to the benefits they are likely to experience on such a rate. To ensure that the utilities take a proactive approach, we also recommend that the Commission establish target enrollment levels for customers with smart technologies (such as grid-integrated water heaters and EVs).

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[23] D.15-07-001, pp. 145-146

[24] D.15-07-001, p. 176

[25] Decision 18-08-013 in A.16-06-03, Application of Pacific Gas and Electric Company to Revise its Electric Marginal Costs, Revenue Allocation and Rate Design, August 17, 2018, at 48.

H. PG&E's Proposed Pilot E-DER-A Rate Should Not Be Approved

Although we support the development of innovative rate designs, PG&E's proposed E-DER-A should not be approved. PG&E claims will incent DERs "to operate in a way that both meets grid needs and aligns with the state's greenhouse gas goals."[26] However, rate E-DER-A contains several problematic elements,[27] chief among them being the inclusion of a non-coincident demand charge of $11.63/kW-month based on the average demand during the highest 30 hours of demand during a billing cycle.

The inclusion of a large non-coincident demand charge is problematic for beneficial electrification and efficient use of the grid. As recently stated by the CPUC:

> *Noncoincident demand charges incentivize customers to flatten their load, but given high penetration of solar resources, solar-following loads are becoming more desirable to avoid curtailing renewable resources and may be less costly to serve than customers with flat loads. Noncoincident demand charges can discourage beneficial energy use, such as electric vehicle fleet charging (overnight or during hours with high solar generation), or Reverse Demand Response to encourage customers to use renewable energy that might otherwise be curtailed due to over-generation conditions.*[28]

Although a demand charge can help incentivize storage, demand charges should not apply during off-peak periods, except in very rare circumstances (for, say, demand over a very high threshold). Further, there exist alternative ways of incentivizing storage, such as through dynamic hourly rates that reflect both marginal energy costs, as well as generation and distribution capacity costs. Finally, TOU rates with high on-peak to off-peak price differentials can help incentivize storage. Thus PG&E's proposed E-DER-A rate represents a step in the wrong direction for beneficial electrification and should not be approved. Instead, PG&E should continue to explore alternative rate designs and seek stakeholder input regarding the rate designs that would be most beneficial.

I. Conclusions and Recommendations

Rates with larger peak/off-peak differentials provides bill savings for customers who invest in beneficial electrification technologies, and better reflects the costs these customers

[26] PG&E RDW Testimony, page 1-10

[27] While we have concerns regarding the proposed fixed export credit rate and an indifference transition credit, we do not address those concerns at this time.

[28] CPUC D.17-08-030

impose (or avoid) on the electric system. Such rates also ensure that customers who invest in these technologies utilize them in a manner that is beneficial to the grid, rather than at odds with it.

The rates proposed by PG&E and SCE fail to provide sufficient price signals to customers and do not improve the economics for customers who adopt beneficial electrification technologies. Further, both of PG&E's proposed TOU rates deviate substantially from its marginal costs.

Rather than moving its rate offerings toward more cost-based rates, PG&E's proposed rates – and its proposal to phase out more cost-based rates -- represent a step backward from more cost-based current rates. Currently, approximately 95,000 customers take service on rate schedule E-6,[29] which has a summer peak to off-peak price ratio of 2.07, substantially greater than PG&E's proposed E-TOU-C or E-TOU-B price ratios. However, PG&E states that it plans to phase out this rate by 2023, with E-6 customers being migrated to PG&E's then-existing default TOU rate schedule.[30]

The introduction of default residential TOU rates provides the opportunity to greatly increase customer awareness and engagement with their electricity rates and consumption.

1) The default TOU rates should have peak to off-peak price ratios that provide a meaningful price signal for customers. Our analysis indicates that the utilities' proposed TOU rates would provide bill savings of only about $5 per month for customers with space or hot water heat pumps who shift their entire space or hot water heat pump load off of peak hours. Such savings are unlikely to motivate behavioral change or drive customer adoption of smart appliances, despite their potential to serve as a valuable grid resource for load shifting and flexibility.[31] Further, the vast majority of EV owners currently take service on standard residential rates. Under the utilities' proposals, these customers would be moved to one of the utilities' default TOU rates. Without meaningful

[29] PG&E Testimony December 2017, at 2-20.
[30] PG&E Testimony, 2-20.
[31] Ryan Hledik, Judy Chang, and Roger Lueken, "The Hidden Battery: Opportunities in Electric Water Heating," n.d.

price signals, these EV customers are much more likely to simply plug in when they get home from work, exacerbating evening peaks and driving up costs for all customers.[32]

2) The utilities should propose a menu of rate options that include proposals that would provide substantially stronger price signals than the default TOU rates.

3) The utilities should take advantage of this opportunity to default customers with beneficial electrification technologies, particularly EVs, onto rates that would provide strong incentives for shifting load off-peak. Examples of such rates include SCE's PRIME rate schedule and PG&E's EV rate schedules. This recommendation does not apply to PG&E's E-DER-A rate, this rate does not provide useful price signals.

4) The Commission should not approve PG&E's E-DER-A pilot, as the inclusion of a large non-coincident demand charge of $11.63/kW is inconsistent with the principles of cost causation and encouraging beneficial energy usage, as recently reiterated by the Commission in D. 18-08-013 PG&E's GRC Phase II proceeding.

5) SCE's rates should be simplified to no more than three TOU periods that are constant throughout the year, even if the prices during those periods change. Doing so will make it easier for customers to understand the rates and to respond accordingly.

III. CONCLUSION

To comply with PU Code § 740.12 and to meet California's climate and clean energy goals in the most cost-effective manner, the Commission should adopt the recommendations made above.

Dated: October 26, 2018

Respectfully,

/s/ Max Baumhefner
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[32] As noted in the 6th Joint IOU Electric Vehicle Load Research Report: December 2017, p. 93: EV customers that remain on typical residential rates tend to show less usage during the off-peak hours and "increased usage during the afternoon-evening hours relative to those on PEV rates."

Attachment A: Statement of Qualifications for Max Baumhefner

Max Baumhefner is an attorney and expert in clean vehicles and fuels, within the *Energy and Transportation Program* of the Natural Resources Defense Council (NRDC) based in San Francisco. Since joining NRDC in 2010, his focus has been on policies to accelerate the electrification of the transportation sector and to ensure the efficient integration of electric vehicles into our nation's utility system. Mr. Baumhefner has testified and presented on energy issues before the California State Legislature, the California Energy Commission, the California Public Utilities Commission, the California Air Resources Board, and before similar bodies across the country. He holds a bachelor's degree from Pomona College and a Juris Doctor from Boalt Hall at the University of California, Berkeley.

Attachment B: Statement of Qualifications for Melissa Whited

Melissa Whited is a Principal Associate at Synapse Energy Economics, where she has worked extensively on issues related to utility regulatory models, rate design, and policies to address distributed energy resources (DER). In the rate design arena, Ms. Whited's work focuses on the development of rate designs that effectively balance the fundamental principles of revenue sufficiency, fair apportionment of costs, and efficiency of use. She has authored numerous reports and testimony regarding the impacts of fixed charges and demand charges on low-income customers, customers with distributed generation, and the ability of states to achieve their energy policy goals. Ms. Whited has testified on rate design matters before the Massachusetts Department of Public Utilities, the Texas Public Service Commission, and the Public Service Commission of Utah. In addition, she has filed testimony on performance-based regulation and market power before the Hawaii Public Utilities Commission and the Federal Energy Regulatory Commission, respectively. Ms. Whited holds a Master of Arts in Agricultural and Applied Economics and a Master of Science in Environment and Resources, both from the University of Wisconsin-Madison.

Attachment C: Exhibit 2: Marginal Cost Revenues from PGE's 2017 GRC Phase II (A.16-06-013 Workpapers, dated 12/2/16

Generation and Distribution Variable Costs Using Proposed C/I TOU Periods

Primary Distribution

	Summer Peak	Summer Part Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak	Total	
E-1	$129,177,550	$56,502,961	$28,444,491	$9,121,971	$8,283,677	$231,530,650	
EL-1	$47,528,539	$20,789,241	$10,465,635	$3,356,264	$3,047,829	$85,187,507	
						$316,718,157	66.4%

Generation Capacity

	Summer Peak	Summer Part Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak	Total
E-1	$123,737,039	$9,477,995	$0	$0	$0	$133,215,034
EL-1	$53,011,307	$4,060,554	$0	$0	$0	$57,071,861
						$190,286,895

Energy

	Summer Peak	Summer Part Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak	Total
E-1	$108,589,913	$68,017,139	$84,592,067	$165,594,845	$195,098,000	$621,891,964
EL-1	$46,521,989	$29,139,839	$36,240,855	$62,784,365	$73,970,322	$248,657,370

Forecast Bundled kWh

4-Month Smr	Summer Peak	Summer Part Peak	Summer Off Peak	Winter Peak	Winter Off Peak	Total	
E-1	2,055,842,443	1,678,065,722	2,968,453,389	3,694,729,134	7,575,737,310	17,972,827,998	
EL-1	880,762,107	718,915,356	1,271,742,040	1,400,836,005	2,872,298,672	7,144,554,181	
Total	2,936,604,550	2,396,981,079	4,240,195,429	5,095,565,139	10,448,035,982	25,117,382,179	38.1%
	11.7%	9.5%	16.9%	20.3%	41.6%		
2014 Hourly							
5pm-10pm Peak	3,482,607,678	2,293,879,586	5,516,468,099	5,248,894,576	13,163,104,195	29,704,954,134	38.0%
	11.7%			17.7%			
Scaling Factor	99.7%			114.8%			
4pm-9pm	2,370,544,467		8,922,410,896	3,394,933,384	15,017,065,387	29,704,954,134	
ETOU-B	2,363,978,557		8,928,976,806	3,897,716,764	14,514,282,007		
3pm-8pm ETOU-A	2,271,724,517		9,021,230,846	3,111,725,413	15,300,273,358	29,704,954,134	

Total Marginal Costs per kWh

Summer Peak	**Summer Part Peak**	**Summer Off Peak**	**Winter Part Peak**	**Winter Off Peak**
$0.17584	$0.07985	$0.03808	$0.04729	$0.02685

NRDC Analysis of Marginal Costs per kWh

Total Marginal Costs per kWh

Summer Peak	Summer Part Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak
$0.1758	$0.0799	$0.0381	$0.0473	$0.0269
Summer Differential		$0.14	Winter Differential	$0.02
Peak to Off-Peak Ratio		4.62	Peak to Off-Peak Ratio	1.76

Generation Costs Only per kWh

Summer Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak
$0.1130	$0.0349	$0.0448	$0.0258
Summer Differential	$0.08	Winter Differential	$0.02
Peak to Off-Peak Ratio	3.24	Peak to Off-Peak Ratio	1.35

Generation and Distribution Costs per kWh

Summer Peak	Summer Off Peak	Winter Part Peak	Winter Off Peak
$0.1758	$0.0532	$0.0473	$0.0268
Summer Differential	$0.12	Winter Differential	$0.02
Peak to Off-Peak Ratio	3.31	Peak to Off-Peak Ratio	1.98